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FORTIFICATION OF WHEAT WITH VITAMIN A IN BANGLADESH 1/

TRIP REPORT

November 6 - 25, 1987

by

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Fortification of Wheat with Vitamin A in Bangladesh

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I. PURPOSE

The purpose of the trip described in this report was to provide technical assistance to Helen Keller International (HKI), a U.S. based private voluntary organization, in preparing for the implementation of their project for the vitamin A fortification of wheat in Bangladesh. Technical assistance was to be provided to HKI and the Government of Bangladesh personnel as well as counterparts in a local consulting firm which will carry out the technical activities of the project. These activities will include production of vitamin A fortified wheat and a quality assurance program designed to assure the receipt of fortified wheat by intended recipients in the Vulnerable Group Development (VGD) and Food for Work (FFW) programs

The following Scope-of-work was designed for completion on this trip.

1. Develop plans and recommendations for modification of the in-country silos that will readily permit the fortification of wheat through the use of vitamin A premix.

2. Prepare flow sheets, sketches and equipment information sufficiently detailed to allow follow-up by local counterparts.

3. Develop procedures for control of the wheat premix at the port and at the silo during use.

4. Develop a quality assurance program for production procedures, quality control testing and distribution monitoring to ensure receipt of vitamin A fortified wheat by VGD and FFW program recipients.

5. Demonstrate the utility of premix wheat by preparing fortified wheat, whole meal (atta) and chappati and analyzing for vitamin A content.

6. Advise HKI on follow-up activities needed to help assure the fortification system is operational and tested by May 1988.

II. SUMMARY

All points in the Scope-of-work were addressed but in some instances not with the intensity and in-depth analysis that is customary due to the paralyzing strikes and civil disorder prevalent during the period of the visit. Transportation was difficult and data gathering hampered because of unavailability of local counterparts. Technical assistance was provided in the areas of (1) designing a system for wheat fortification using vitamin A premix, (2) defining engineering modifications to the silos to permit fortification, and (3) developing a quality assurance program to control production and distribution of fortified wheat.

A food processing engineer was a member of the team during the visit and planned the silo modifications and the design of the fortification system. Silo modifications were outlined, equipment identified as needed and a fortification unit designed. Drawings, sketches, and information were left to aid in the purchase, installation and operation of the fortification unit.

A fortification unit was designed by integrating the operation of a metering conveyor and a premix feeder to add controlled amounts of wheat and premix simultaneously into the system through a splitter cone to produce mixing of the components. Transport of regular wheat before and fortified wheat after the fortification unit as well as the bagging process is the same as for regular silo operations. When fortified wheat is not being produced simple adjustment

of a valve and flow indicators provides for by-passing the fortification unit and processing wheat in the usual manner. Each bagging line so equipped can produce up to 60 tons per hour of fortified wheat. To satisfy the needs of the demonstration project this will include operations equivalent to one day per month for seven months to meet the VGD program needs and up to six days a month for the five months the FFW requirements are added.

A plan was developed which describes the secure handling of premix wheat upon arrival in the country to prevent leakage into the economy with unintended use. Secured containers will be used to transport the premix from the port to the silo and will be used as a storage facility until the premix is used. Possibilities are being explored for purchase of used seafreight containers to be used for storage at the silos.

A quality assurance program was developed that would ensure proper vitamin A levels in all materials and verify proper distribution of fortified wheat. The program includes analysis of incoming premix wheat, control of the production process, application of quality control procedures during production, and monitoring the distribution system to point of issuance of fortified wheat to program recipients.

The procedure to be used to determine the presence, correct level and uniform distribution of the premix kernels in fortified wheat is based on the ability of premix kernels to fluoresce under ultraviolet light. Supporting data for controlling the vitamin A content of fortified wheat will be gathered from the analytical assay of wheat samples using High Performance Liquid Chromatography (HPLC) methods. Samples of fortified wheat will be taken frequently during the production and checked for accuracy of fortification. The fortification unit

will be adjusted if necessary to assure the correct vitamin A level in the fortified wheat. Complete bags will be sampled periodically to test for uniformity of distribution of the premix. During the demonstration project samples will be drawn from bags of fortified wheat at different points in the distribution system such as CSD, LSD, Upazilla and union issuance points. Locations to be sampled will be selected randomly each month.

The use of premix wheat was demonstrated by producing fortified wheat and testing the fortified products for vitamin A content. Fortified wheat was prepared with 10,000 IU of vitamin A per kilogram. The wheat was ground into whole kernel meal (atta) and the meal used to prepare chappati. Fortified wheat was provided to two institutions for assay while only one also received fortified meal and chappati. Vitamin A assay results are not available at this time. They will be made available when completed and analyzed.

Sufficient information was provided for the development of purchase specifications of the fortification unit equipment and quality assurance materials. In addition, a quality assurance program outline was completed which needs only rounding-out to be operational.

III. BACKGROUND

Vitamin A deficiency has been identified as a serious nutrition problem for the people in Bangladesh. Reports on several recent studies done in Bangladesh have established that as many as 70,000,000 people are affected by vitamin A deficiency with 900,000 children under six years of age suffering from eye disease and perhaps 30,000 children blinded each year due to severe vitamin A deficiency (4)(7).

In general, the vitamin A deficiency is most severe among low income groups whose diets are substandard. The disease seems to follow education and socioeconomic development with the poorest children in the country at the highest risk of vitamin A deficiency. The prevalence is highest in areas of greatest distress. Therefore programs that are directed toward improving vitamin A nutrition are more likely to be successful when targeted directly to segments of the population at the highest risk of deficiency.

One effort in this direction is the Bangladesh Programme for the Prevention of Blindness (BPPB) which is active in the distribution of vitamin A capsules which reach 8 million children and prevent perhaps 8,000 children from going blind each year. However, compliance does not always reach the poorest and neediest candidates on a regular basis. Helen Keller International (HKI), a U.S.-based private voluntary organization seeks to expand the effort and coverage for availability of vitamin A to reach more people in the at-risk group. It has actively pursued the development of additional programs which could more adequately meet the problem of reaching the poorest of the poor on a regular, sustained basis. One such program is a nutrition intervention for the vitamin A fortification of wheat.

Crowley (3) carried out a feasibility study to identify foods in Bangladesh that are available to and consumed by those groups more vulnerable to vitamin A deficiency and which might be vehicles for vitamin A fortification. Wheat was identified to adequately meet the criteria and conditions for a good vehicle. The major programs that vitamin A fortified wheat would be used for are the Vulnerable Group Development (VGD), formerly the Vulnerable Group Feeding (VGF) program, and the Food for Work (FFW) program.

Barrett (2) then conducted a logistics and engineering study to determine the feasibility of fortifying imported wheat in Bangladesh, to identify constraints to doing this and to identify the follow-on activities for developing a project for the vitamin A fortification of wheat in Bangladesh. The feasibility was positive. It showed that imported wheat could be fortified with vitamin A through a simple process of mixing a small amount of vitamin A "premix" kernels with whole wheat using a typical food fortification technique 1/. The premix kernels and the resulting fortified products are indistinguishable from unfortified products. The process could be done in the existing silos with a minimum of modification. Equipment required for the process is simple and relatively inexpensive. Based on the study results HKI developed a project proposal which received approval and funding from the Agency for International Development (AID) (8).

Helen Keller International requested technical assistance for planning the implementation activities (1). The substance of this report describes the technical assistance given in the areas of (1) design of a system for wheat fortification using vitamin A premix, (2) defining engineering modifications to the silos to permit fortification, and (3) developing a quality assurance program to control production and distribution of fortified wheat.

IV. SILO MODIFICATION

The HKI program includes a three year demonstration project that calls for the fortification of 30,000 tons of imported wheat over a 12 month period. This project will demonstrate the operational reality of wheat fortification, show the efficiency of distribution to program recipients, and verify the intended nutritional impact of the program.

1/ Premix consists of ordinary grains of wheat to which vitamin A preparation has been attached using edible adhesive materials.

The activities of fortification, distribution and quality assurance will be carried out following prescribed protocol. The outputs of the visit described in this report included the development of the plans and in some cases, considerable detail of the various protocols to be used.

The silo at Ashuganj was designated as the facility to be used in the demonstration project because of its proximity to the testing area, its full range of equipment and an operating schedule that can accommodate the extent of interruption that might be needed to modify it to produce fortified wheat. The construction and operational flow of the silo was studied in relation to what equipment would be needed for fortification and where it could be installed. Production information showed that one bagging line unit was producing up to 60 tons of bagged wheat per hour. At that rate the project requirements could be met very easily utilizing one line so there was no requirement for designing a modification for fortifying at 200 tons an hour if it wasn't the best alternative. It was determined that modification of one bagging line would be more than adequate for the project and when the full, national program is initiated the fortification system could be easily replicated in each of the silos as needed to expand production of fortified wheat.

Details of the silo modification can be found in the Munson report (5) (Appendix B). Briefly it involves the construction of a mezzanine floor above the bagging line that will support the fortification unit, the quality control room and an operational quantity of bagged premix. The bucket elevator will be extended just through the ceiling of the bagging area to allow for adequate flow of regular wheat from the elevator into the holding hopper on the fortification unit. The spouting from the head of the elevator will be equipped with a diversion

valve that will allow for a direct switch of wheat to the fortification unit when in operation and back again to regular flow at other times. There are no changes to the dumping scales or other parts of the bagging operation. Likewise there are no changes in the flow of regular wheat from the holding bins through the screw conveyor or in the elevation process.

As mentioned, the mezzanine will be constructed to hold the fortification unit (described later), the quality control room and limited quantity of bagged premix wheat. The quality control room will be big enough for a table and the equipment needed for the quality control function when producing fortified wheat. A storage area will be designated to accommodate sufficient premix for up to four hours operation at the start of a shift and replenished during production. Details of the Quality Assurance Program appear in Section VI.

A cone splitter will be installed in the surge hopper of the scale bin directly beneath the output of the fortification unit. This will enhance the mixing of the premix with the wheat for desired distribution.

There will be certain modification of the electrical wiring to have critical interlocks established that will prevent over-fortification of the wheat or overloading and damage to the equipment.

Sketches of the silo modifications are in Appendix B.

V. FORTIFICATION UNIT

Early consideration of program requirements indicated that production at something less than 200 tons per hour would be sufficient and preferred from a quality assurance standpoint. Consequently the production capacity of a single bagging line determined the rate to guide on and the size of equipment needed.

The fortification unit is comprised of two pieces of equipment working in coordination. They are (a) a heavy duty metering conveyor for feeding regular wheat at a controlled rate in the range to exceed 60 tons per hour, and (b) a small chemical-type feeder capable of adding relatively smaller quantities of premix kernels with an operating capacity between 400 and 800 pounds per hour.

The equipment is mounted so that the material coming from the outlet of each machine falls together for preliminary mixing then falls against a splitter cone which gives further mixing to the wheat/premix kernels. This mixture falls into the surge hopper on the scale dump bins where further mixing occurs as the grain tumbles during the filling and discharge of the bins.

The metering conveyor has a surge hopper above the intake equipped with Hi-low bin controls that can control the screw conveyor, elevator etc. to regulate the input of wheat. In addition, it has a low bin indicator that controls the premix feeder so there can be no addition of premix without sufficient flow of regular wheat.

When fortified wheat is to be produced the by-pass value is opened, the fortification unit turned on and the wheat flow started. This line will be producing and bagging fortified wheat. Production can be stopped by closing the by-pass value. This directs regular wheat in the normal manner with regular wheat being bagged.

VI. QUALITY ASSURANCE PROGRAM

A Quality Assurance Program represents a broad system of concerns that are applied in the attempt to guarantee satisfactory performance or a certain outcome such as the proper manufacture of a product etc. In the case of the fortification of wheat with vitamin A in Bangladesh, it includes the transport and

use of the premix, satisfactory production of fortified wheat, and adequate distribution of the fortified wheat to intended target recipients.

Appendix C contains the details of the different phases of the Quality Assurance Programs. Highlight of that program will be covered here.

A. Premix Transport - Protection of the premix against loss and possible misuse is of prime importance to the Quality Assurance Program and to the HKI project. Plans will be made for the premix to be shipped and held in locked containers from its production until use in the silo to make fortified wheat. At the silo, premix will be in locked storage with only designated people having access and control sufficient to account for all bags.

B. Quality Control - To assure the production of fortified wheat with the correct level and proper distribution of vitamin A various quality control activities will be carried out. The vitamin A content of the premix will be determined. The level determines the addition rate needed and the QC standards to be used for the finished product.

Samples of wheat will be drawn every 15 minutes from one or two places in the production line and tested for the presence and correct amount of premix kernels. Hourly samples will be kept and submitted for vitamin A analysis by analytical methods. Should unsatisfactory readings be obtained, adjustment of the settings on the fortification unit will be made to bring the product back to specification.

The technique to be used for on-line quality control as well as testing samples from distribution monitoring, etc. is based on the use of a portable

ultraviolet lamp. Premix kernels fluoresce brightly when subjected to ultraviolet light in darkened surroundings. Fortified wheat is spread on a table in a darkened area and the UV lamp passed over the sample. The premix kernels will appear as bright yellow kernels among the brown wheat.

There should be a certain number of premix kernels in a given amount of fortified wheat, such as 10 premix in 100 grams of wheat. It requires about 5 minutes to run a test. A 100 gram sample is weighed on a simple balance, spread on the table and illuminated with ultraviolet rays. The presence of premix kernels is determined and the number counted.

Bag identification will be an important factor. Bags to be used for fortified wheat will have a distinctive colored stripe woven in or painted onto it to clearly identify it as fortified wheat. In addition, each bag will be coded in one of several ways still under consideration to indicate the month and location, etc. of production as well as again indicate it contains fortified wheat.

The production control monitor will keep adequate records of production and use of premix to indicate proper addition rates are being used and to account for all premix. Also he will work with the loading dock operators to check that trucks with fortified wheat are going to the proper LSD's and other distribution points as prescribed by the HKI project.

C. Distribution - Each month one or two CSD, LSD or smaller issuance points will be picked at random for monitoring. A bag marked fortified wheat will be selected, a sample taken and the sample checked for presence and correct amount of premix. This same technique can be used to check for the presence

of fortified wheat in the open market due to system leakage or having been sold by program recipients.

D. Analytical Support - In addition to the rapid on-line non-destructive testing of fortified wheat for the presence and semi-quantitative estimate of vitamin A levels, the same sample will be analyzed by analytical procedures for accurate vitamin A content. The results of the assays will be correlated with the on-line date to see that the addition rate and premix kernel count being used produces fortified wheat with the intended level of vitamin A.

Two institutions were contacted regarding their ability to perform vitamin A analyses and their interest in providing analytical support for the HKI project. Discussions were held with key personnel at the Institute of Nutrition and Food Science (INFS), University of Dhaka and at the International Center for Diarrheal Disease Research, Bangladesh ((ICDDR-B). Both institutions are capable and willing to participate in the project. Each one would use High Performance Liquid Chromatography (HPLC) procedures for vitamin A assay. This is fortunate as it will provide a measure of correlation between the two institutions as well as with Iowa State University (6) who is serving as the technical center for USDA in the development and implementation of the technology for the vitamin A fortification of wheat.

Samples of premix kernels and fortified wheat were provided to each institution for preliminary testing. In addition, meal and chappati made from fortified wheat were provided to ICDDR-B for testing. The INFS is producing the meal and baking the chappati from the fortified wheat in their own facilities.

The results of this testing will be submitted to USDA through HKI for review. Plans will be developed for the efficient use of both institutions for analytical support during the demonstration project.

V. DEMONSTRATION OF UTILITY OF PREMIX

The use of premix kernels and the associated fortification technology for the vitamin A fortification of wheat has been successfully demonstrated in the laboratory and small pilot tests in the U.S. Criteria for success are that the fortified and unfortified products are essentially the same in all aspects of acceptability i.e. color, taste, etc. and that there be no nutritionally significant loss of vitamin A during the blending, grinding and baking.

It was desirable to demonstrate the utility of the premix in real life conditions in Bangladesh so tests were carried out by preparing fortified wheat, producing whole meal (atta) and chappati from the wheat and analyzing all products for vitamin A content.

Wheat was purchased from the market and blended with premix kernels to produce fortified wheat. The wheat was ground in a chuki mill to produce whole grain meal (atta). Samples of atta were collected during the early, middle and latter periods of the grinding operation. Ten kilograms were ground over a period of 11-12 minutes. The temperature of the atta ranged between 110-120°F. Samples of atta were distributed to three women representative of recipients of the VGD or FFW programs who made it into chappati. Samples of wheat, atta and chappati were provided to ICDDR-B for analysis of vitamin A content. Laboratory work is in progress. Results will be reported when they are available.

VII. FOLLOW-UP TOWARD IMPLEMENTATION

A. Silo Modification - Sufficient information was left through meetings and documents so that the local consultation firm, which will implement the project, can start equipment purchase and complete plans for the silo modification. Target dates discussed were for silo conversion completed and equipment arrival by June 1, installation and initial operation by July 1 with regular production of fortified wheat to begin soon after July 4, 1988.

B. Quality Assurance Program - A rather complete outline of a Quality Assurance Program was prepared which covered all major areas of activity and included a list of instruments and materials needed for the program. The outline needs to be rounded-out with operational details that can be resolved with little further study. These last details regarding staffing and managing the operation of the fortification unit, marking bags of fortified wheat and distribution monitoring must be worked-out in cooperation with the Ministry of Food which is responsible for the handling of grains and the operation of the silos.

C. Technical Assistance - It has been requested that all plans, drawings, etc. to be used for silo modification as well as the final detailed version of the Quality Assurance Program be submitted to USDA for review before finalization. These reviews are to be part of the follow-up technical assistance to be provided by USDA. In addition, it will include assistance in completing a detailed implementation plan (Feb. 88), assistance in installation, calibration and start-up of the fortification unit (June 88) and year end review and second year planning (Oct. 88).

D. Other Implementation Questions - Answers were provided to HKI on other questions regarding implementation. They involved anticipated tasks and responsibilities to be borne by different Ministries of the Government of Bangladesh during the project. Adequate cooperation of the GOB is needed to ensure satisfactory completion of the demonstration project and implementation of the national program for wheat fortification.

The possibility of purchasing a used 20-foot sea-container is being explored. It would be used at the silo for secure storage of the premix bags between arrival and its use to produce fortified wheat. Similar units could be installed at each silo producing fortified wheat during the expanded National Program.

The matters of consignee for the premix in Bangladesh who will control it after arrival and who is responsible for it until it is used to make fortified wheat need to be discussed with the GOB, World Food Program and others before any orders are placed or activities started.

Coordination needs to be worked out with the analytical support institutions regarding vitamin A analysis of fortified wheat. Adequate Quality Assurance support will entail timeliness so that the on-line control can be determined to be adequate. Scheduling of sample analysis will be important to help ensure this.

REFERENCES

1. Department of State Cable (Dhaka 6847) September 16, 1987.

2. Barrett, F. F. - Fortification of Wheat with Vitamin A, Trip Report. Bangladesh November 5-26,1986.

3. Crowley, P. R. - Fortification of Food with Vitamin A Trip Report, Bangladesh. July 29 - August 11, 1986.

4. Helen Keller International - Bangladesh Nutritional Blindness Study 1982-1983 HKI and Institute of Public Health Nutrition Bangladesh 1985.

5. Munson, J. T. - Fortification of Wheat with Vitamin A Premix in Bangladesh Silos. Consultants Report. November 6-25, 1987

6. Murphy, P. et al. - Vitamin A Fortification for Developing Countries. Quarterly Report. Food Technology Department, Iowa State University. September 1986.

7. Joint Who/FAO Mission Report UN Ten Year Action Programme Against Vitamin A Deficiency in Bangladesh. March 18 - April 12, 1986.

8. Helen Keller International - Fortification of Wheat with Vitamin A in Bangladesh: A Demonstration Project. HKI/New York and HKI/Bangladesh. April 1987.

APPENDIX A

People Contacted

Helen Keller International

Anthony Drexler, Country Director
Ian Darnton-Hill, Asst. Dir. Res./Eval.
Mira Mitra, Asst. Dir. Program

U.S. Agency for International Development

Alan Hurdus, FA
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Dr. Anwarul Huq
Dr. Wahed
Dr. Mujibar Rahman

Institute of Nutrition and Food Science - U. of Dhaka

Dr. Md. Malek, Director
Dr. Galam Mowlah
Dr. Quazi Salamatullah

CARE

Stafford Clary

Homebound Packers

Anselm Quiah, Owner
Dewan Siddique

American President Lines, Ltd. - Shaw Wallace B Ltd.

Shamsul Alam, Mgr. Shipping Dept.
Jasim Ahmed, Shipping Agent

Maersk Line - Seagull Assoc.

Zabed Sharfuddin, Agent

Shipping Corporation of India - Samudrajatra Shipping Lines, Ltd.

B.Z. Khundker, Exec. Director

CONSULTANTS REPORT

Fortification of Wheat With Vitamin A
Premix in Bangladesh Silos

James T. Munson

Nov. 6, 1987 To Nov. 11, 1987

Fortification of Wheat With Vitamin A in Bangladesh Silos

James T. Munson

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Prior to leaving California I reveiwed the project reports and plans of HKI Bangladesh, Fred Barrett and other material on the fortification of wheat with Vitamin A.

According to the Scope of Work prepared by USDA, the basic objective was to recommend modifications to the Chittagong silo to produce fortified wheat at a rate of 100 to 200 tons per hour, using large bins to store premix and the fortified product.

In preparation for the trip I contacted several manufacturers of metering conveyers and feeders and requested engineering data. I also consulted associates who have had many years of experience with the development, preduction and feeding of premix in Rice.

Machinery capable of accurate metering of grain at rates of up to 200 tons per hour are available only on special order. The feed screws required would be up to 24 inches. That size of equipment would be very difficult to locate in the Bangladesh Silo System.

The use of large bins to handle premix is also not recommended because the friction of the product moving in the bin will flake off the enriched coation. It was our experience not to store bulk premix in bins larger than 300 cwt. capacity.

At this point I was convinced that the most logical place in the silo system to fortify the wheat in the silos of Bangladesh was just ahead of the bagging system.

Considering the fact that for the first 14 days of this assignment I was only allowed approximately two hours in the Ashuganj silo and not more than two hours in the Narayanganj silo, I am still of the opinion that the best location in the silo flow system to fortify wheat would be just ahead of the bagging system for the following reasons.

(1) Each bagging line equipped with a metered feed and a metered premix feeder could operate separately from the other lines bagging regular wheat without slowing down total production.

(2) With the third floor plan, the fortification operation would be in an area away from the other operations.

(3) Quality Control, Operational Control and Security of premix storage would all be in one close area.

(4) Smaller equipment would be used on a single line and the initial cost would be lower.

(5) Modification to the Silo complex would be minor considering the overall value of the facility.

(6) It would not be necessary to change the flow of the present weighing and bagging systems.

(7) If the pilot line was acceptable and performed as planned, the same design could be used on the lines in silos of the same design. Other advantages of a Typical Design would be operational simplicity and spare parts inventory.

(8) Quality control procedures, management, employee training, maintenance and general operational guidelines, all would benefit from standardization of each line.

PRODUCTION CAPABILITIES

One Line Pilot Program
Total Production 30,000 Tons

24 Hour Production	1080 Tons
6 days Production	6480 Tons
Total Production Run 30,000 Tons 27.8 days	
Total Program	600,000 Tons
Four Bagging Lines 3 shifts	4320 Tons
One Silo Complex	
Total Production Run 600,000 Tons 138.9 days	

Four Silos with
Four Bagging Lines per Silo
Three Shifts per day
Total Production Run 600,000 Tons 34.7 days

Equipment Needed One Bagging Line

(1) One 12" Metering Conveyor with a Maximum Feed of at least 4141 cu. ft. per hour.

(2) One 2" Feeder with a maximum feed of up to 23 cu. ft. per hour.

(3) Three Bin Control Switches

(4) Feeder design and Specifications for this job (attached) are manufactured by Vibra Screw Incorporated and from my experience with this equipment, I would recommend its use on this project. However please note that other feeders are available and may be preferred.

(5) It is my estimate that the above equipment would cost $25,000 or less F.O.B. Factory USA

(6) Wheat and wheat premix should be one of the easiest products to feed. Feed rates should be easy to establish at the silo. However, Vibra Screw has a test lab that will analyze materials to be used in the process and how their feeders handle the product. The company has a full engineering staff available to answer questions about their equipment.

(7) Any feeder selected should be equipped with a varible speed drive and a calibrated dial. With an accurate scale and a stop watch, preset runs can be made and weight/volume settings can be checked and established on the control knob.

GENERAL OPERATION

Fortification Start Up

(1) Surge Bin SB-2 Bin Controls OFF

(2) Elevator E-1 (ON) Metering Conveyor MC-1 (ON) Premix feeder F-1 (ON) Conveyor C-1 (ON)
Note: Premix feeder F-1 will not start until bottom bin control is covered.

(3) Flow

The feed gate on Storage Silo BB-1 is opened, wheat drops into Conveyor C-1 and is conveyed to Elevator E-1 and is lifted up and discharged into Surge Bin SB-1

(4) At this point the amount of wheat in SB-1 is controlled by the high and low bin controls which start or stop the feed to conveyor C-1.

The position of the top bin control switch must be located low enough from the top of the surge bin to provide room for elevator clean out.

(5) The Premix hopper is full and the premix feeder will run as soon as the bottom bin control is covered and the premix will feed into the discharge end of MC-1.

(6) The flow from metering conveyor MC-1 and premix feeder F-1 discharges into the bagging scale surge bin SB-2 dropping over the splitter cone just below the discharge of MC-1 to provide additional product mixing. The mass again falls into the dump scale and from the scale to the bag.

To evaluate the cone splitter, I constructed a prototype cone splitter in my hotel room. Fred Barrett and I ran several tests using the correct ratios of wheat and premix kernels simulating the combinations of the two being discharged at the end of MC-1. The test runs were discharged into a cardboard box on a 1/3, 1/3, 1/3, basis. Each run was taken into the dark bathroom and light tested. Each 1/3 (on all of the runs) contained an equal amount of premix.

In my opinion this test proves my contention that an equal blend of premix can be obtained without the use of large low capacity blending equipment.

OPERATION

The pilot line should be thoroughly tested on completion of construction and calibration.

Runs should be made at low production rates using food dyed wheat for premix.

Preparations should also be made for quarter hour or half hour tests of the product, tests of the premix supply, etc.

The premix manager should be a qualified cereal chemist or be closely supervised by a cereal chemist.

SHIPPING

(1) A truck arrives at the silo with an order from a LSD or CSD for x amount of fortified wheat.

(2) The silo shipping manager approves the order and on a special colored bill of lading orders the truck to dock one (for example).

(3) Dock one - Bagging Line One has been designated as the fortified wheat line.

(4) The Shift Manager of the fortified wheat program receives the order and checks to see that the truck is in the

right dock space (No. 1).

(5) Starts his fortification line (Line One) and the delivery to the truck is made.

(6) As the delivery is made (in sacks with tags sewn in the bag containing the analysis of the product) the technician on duty samples the delivery using a common small sample tryer.

(7) When the truck is loaded with the correct amount of fortified wheat, the manager receives a signed receipt from the driver of the truck stating that he has on his truck x numbers of bags of fortified wheat. The manager gives him his Bill of Lading or a receipt for the fortified load and the truck leaves.

MAINTENANCE

Since I do not know what equipment will be purchased, it is impossible to prepare a description of maintenance procedures or a list of spare parts.

As a general rule the manufacturer will furnish maintenance manuals for their equipment and will recommend a list of spare parts that should be kept on hand.

ADDITIONAL COMMENTS

Rice Drying, Storage and Processing In Bangladesh

During my visit to Bangladesh and the silos at Ashuganj, Narayanganj, Chittagang and from briefings on the silos at Santaher, Khulna and the general rice industry in Bangladesh, I would recommend that the Government of Bangladesh consider converting part or all of the silos at Ashuganj, Khulna and Santaher to rice drying, storage and milling facilities.

These facilities could be remodeled to dry and store paddy at a fraction of the cost to build new facilities and have the ability to service a rice mill at the same location.

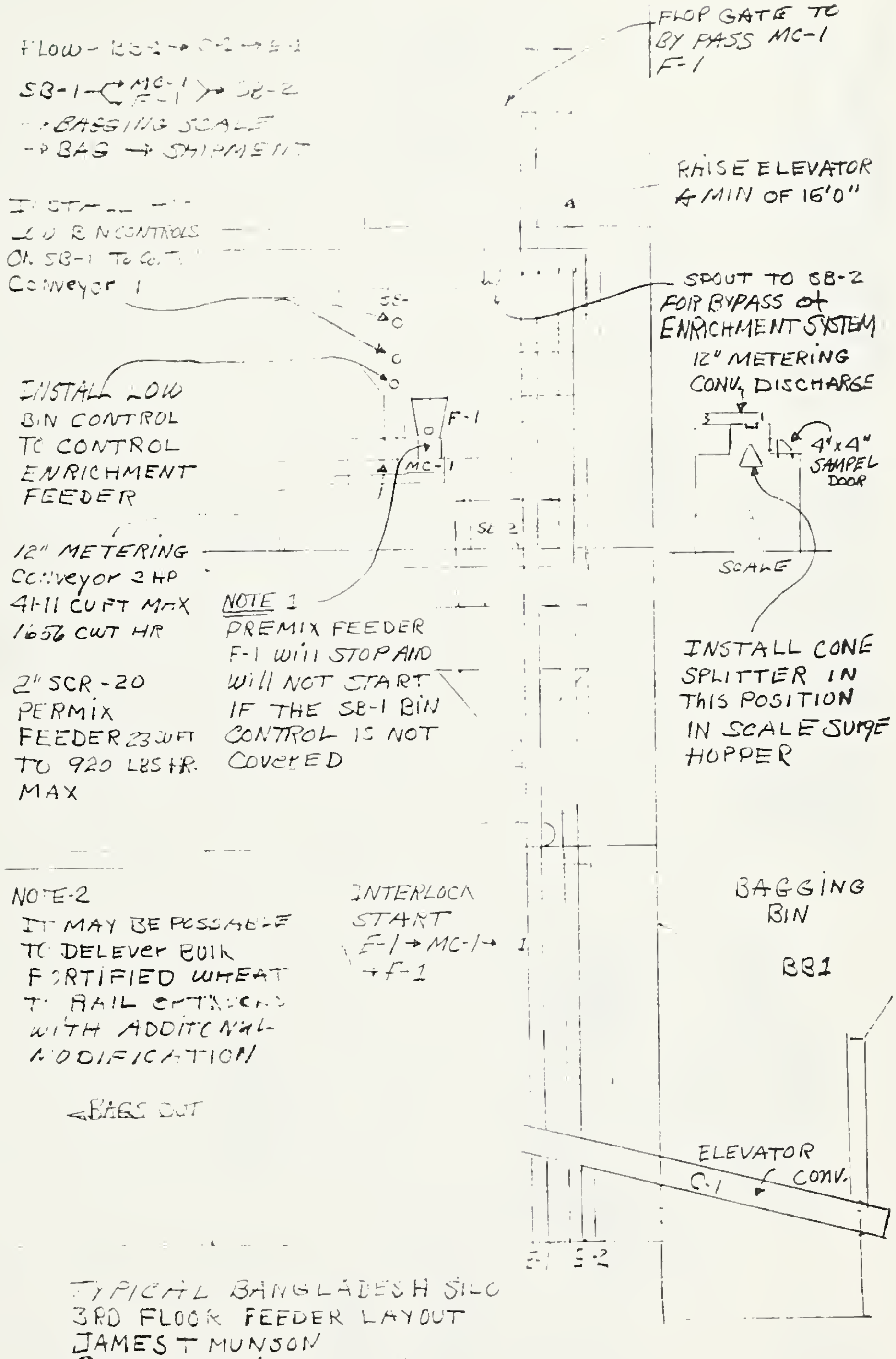
In areas where natural gas is not available, the rice mill could provide fuel from the hulls produced in the milling process. Since a pound of rice hulls can produce up to 6000 BTU's, ample steam and discharge stack heat would be available for power generation and drying of paddy.

If parboiled rice is used in Bangladesh, steam and heat are the major elements needed in this process.

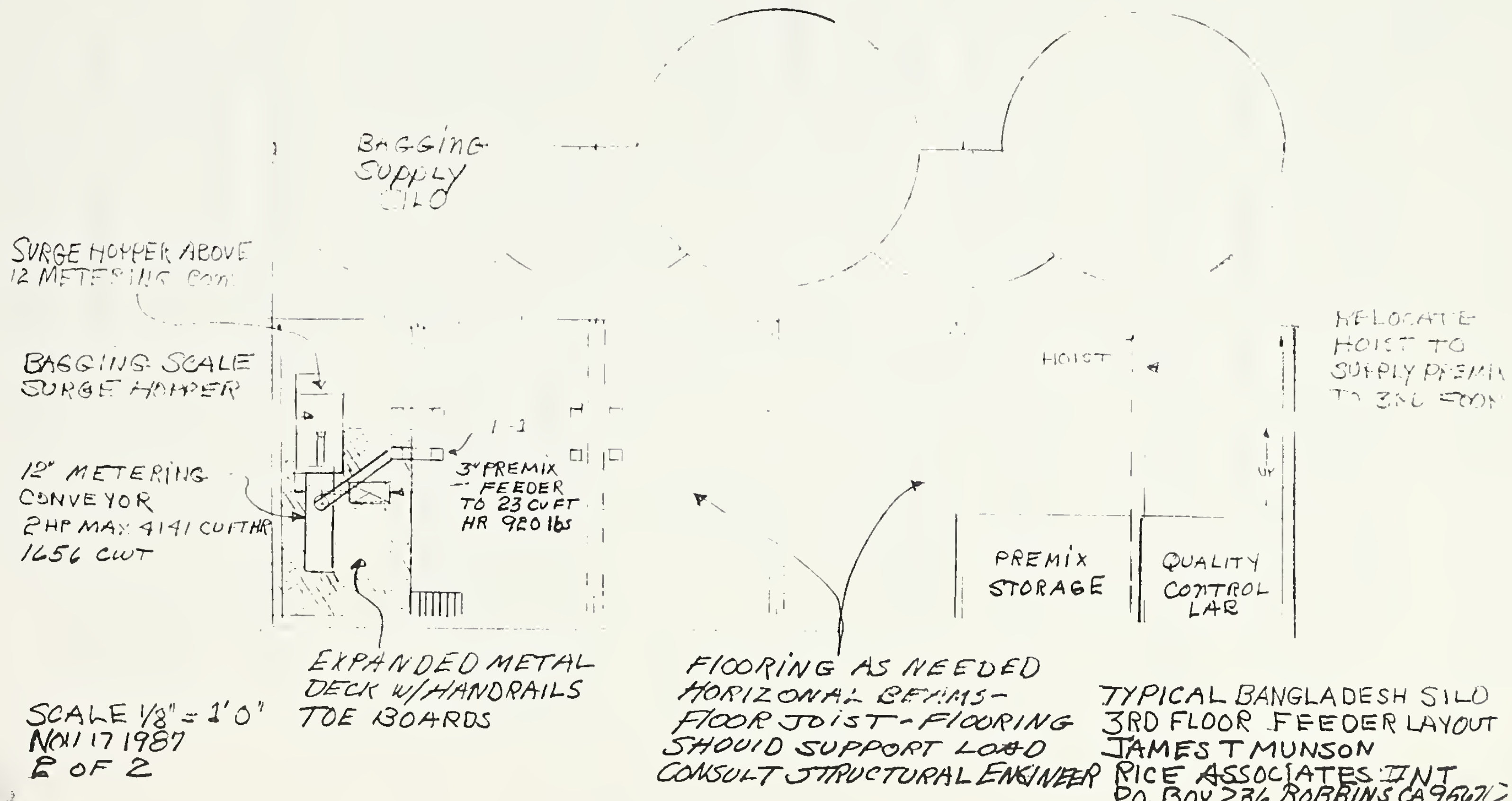
The ability to receive and dry paddy directly from the field could be a huge step forward for the Bangladesh rice farmer. He could harvest his crop at the option moisture (generally about 20% Plus) and benefit from higher milling yields and less spoilage, the direct result of paddy dried under controlled conditions down to 13.5% or 13% moisture.

I did not have the time or the opportunity to study the Bangladesh rice industry in detail. From what I did see, however, controlled drying and storage of paddy rice in good facilities could possibly save thousands of tons of paddy from damage or complete loss.

If a rice mill was built at the above facilities, one additional plus would be the ability to add Vitamin A premix to the rice after milling.



TYPICAL BANGLADESH SILO
3RD FLOOR FEEDER LAYOUT
JAMES T MUNSON
RICE ASSOCIATES INT.
PO BOX 236 ROBBINS CA. 95676 U.S.A.
NOV 17 1967
SCALE 3/16 = 1'0"   1 OF 2


BAGGING SUPPLY SILO
SURGE HOPPER ABOVE 12 METERING CONV
BAGGING SCALE SURGE HOPPER
12" METERING CONVEYOR 2HP MAX 4141 CUFT HR 1656 CWT
3" PREMIX FEEDER TO 23 CU FT HR 920 lbs
HOIST
UP
PREMIX STORAGE
QUALITY CONTROL LAB
RELOCATE HOIST TO SUPPLY PREMIX TO 3RD FLOOR
EXPANDED METAL DECK W/HANDRAILS TOE BOARDS
FLOORING AS NEEDED HORIZONAL BEAMS- FLOOR JOIST - FLOORING SHOULD SUPPORT LOAD CONSULT STRUCTURAL ENGINEER
SCALE 1/8" = 1'0"
NOV 17 1987
2 OF 2
TYPICAL BANGLADESH SILO
3RD FLOOR FEEDER LAYOUT
JAMES T MUNSON
RICE ASSOCIATES INT
P.O. BOX 286 ROBBINS CA 95676

APPENDIX C

Quality Assurance Program

A. Premix Importation and Transport

Premix wheat will be ordered for delivery at quarterly intervals across the year. The quantity ordered will be based on the needed production of fortified wheat for the quarter. The need is uneven across the year as the program requirement vary. For seven months the requirement is low while for five months the requirement is high.

Estimated Premix Requirements per Quarter

Quarter	Premix	No. of Containers
July - Aug - Sept.	13,860 pounds	1
Oct. - Nov. Dec.	35,860 pounds	1
Jan. - Feb. Mar.	79,860 pounds	2
Apr. - May - June	35,860	1

Premix will be bagged in 100 pound bags, stored in sea freight containers in quantity up to 40,000 pounds, locked with lock and key and transported from the U.S. to Chittagong (Ctg). Upon arrival at Ctg port the premix can be handled in either of two ways for transport to the silo for use.

1. The sea freight container can be off-loaded, transferred to a transporter and moved to the silo as is. The container would be used as the secure storage for the period until the premix is used then returned to the international carrier. This would involve transportation cost to the silo and daily rental fee for days of use plus some arrangement for security

deposit for return of container. Fees and conditions vary according to international carrier. Information needs to be gathered on any roadway weight restrictions, on availability of local carriers capable of handling 20 foot sea containers and feasibility of off-loading container at silo or retaining transporter during conversion days.

2. A second option is for the bags of premix to be trans-loaded from the sea container to local containers provided by a local hauler which will be locked then transported to the silo. Possibility should be explored for retention of the containers as security storage at the silo for the period required for conversion. The container would be removed by the local hauler when empty.

Estimated cost for local service described above from one local firm is $1100 to include two 10 ton containers loaded and delivered to silo and retained for up to 7 to 9 days with no holding charge. This would accommodate three of the four production periods in the demonstration year. The heavy production quarter would involve up to four local containers and up to 12 or more days for conversion to hold the containers.

Since secured conditions are needed at the silo for storage of the premix, another option could be to purchase a used container and locate it at the silo to be used for secured storage room. This would allow for unloading of either the sea container or the local hauler containers in a timely fashion and reduce/eliminate any additional charges than necessary transport fees.

B. Bagging Line - Quality Control

Production rate of single bagging line approx. 60T per hour.

1. For Presence, Semi-Quantitative Estimate and Vitamin A Assay

   a. The initial (correct) feed settings will be placed on the fortification unit equipment and the unit started.

   b. A one pound sample should be drawn from the top of a bag selected at random before closing every 15-minutes and the sample analyzed for premix kernels (PK).

      The procedure for analysis: Catch one pound sample in designated container. Accurately weigh 100 grams of subsample. Determine count of PK in subsample using UV lamp. Compare count with expected (control) count. Save each sample and subsample. Combine 4-15 minutes samplings gathered over one hour and submit for vitamin A assay.

C. Hourly combined samples will be taken to ICDDR-B and INFS in determined pattern for vitamin A assay. Assay data will be correlated with PK count.

Standard	Control Level
Premix IU/pound	PK count per 100 g
2.0 mill	10
1.75 mill	13
1.50 mill	15
1.25 mill	18
1.0 mill	20

Alternative

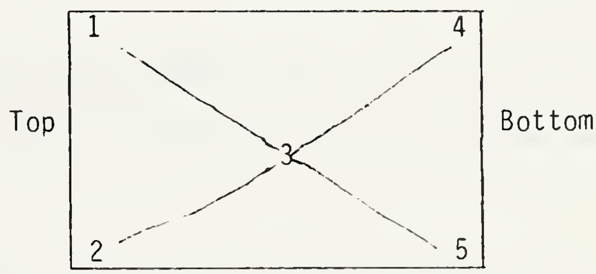
Early in project production it would be informative to have a sample drawn from the top of the weigh bin hopper to check for uniformity of blending at that point and to compare with reading from bag to see if bagging operation has any affect on fortified wheat.

A one pound sample should be drawn and analysed as in above. If counts are uniform, the same as at the bagger etc. the sampling at this point could be discontinued. The sampling could be placed on a 30 minute basis.

2. Uniformity

Initially in the production of fortified wheat, a check should be made to demonstrate the uniformity of distribution of premix in the bag to be used in conjunction with the quantitative data. This can be accomplished by drawing a bag of fortified wheat, laying it flat and cutting open as shown.

Fold bag flaps back. Draw one-pound sample from each numbered location. Analyse 100 gram subsample as in 1b above.



3. Fortification Control

The following feeding (addition) rates of premix are needed per ton of regular wheat to produce fortified wheat.

Premix IU/pound	Grams	Pounds	Operation Rate 60T per hour
2.0 mill	2500	5.5	330 # Premix
1.75	3100	6.8	408
1.50	3750	8.25	495
1.25	4400	9.7	582
1.0	5000	11.0	660

4. Identification of Fortified Wheat

Bags to be use for fortified wheat should be identified with a distinctive colored stripe woven in or painted on the bag such as red, green or orange. Present basic wheat bag has a blue stripe woven in.

In addition, it is desirable to have the bags identified by label, tag or marking that would identify at least date of production (month and year) and silo of production.

Method of identifying production that is best suited is still under consideration. There are pluses and minus for each method. The methods being considered:

1. Stencil/paint on each bag as it is unfolded and stacked.
2. Ink stamp each bag as it is unfolded and stacked.
3. Cloth/paper label stuck to bag before filling which will be caught in stabling of top seam when bag closed. This would be pre-stamped with code related to date and place of production.

Present method and speed of operation presents problems for sewing in identification tag.

Program requirement for color coded bags is 352,941 bags.

5. Release for Distribution

Bagged fortified wheat properly marked will have been checked for the presence and correct content of premix kernels and determined to be acceptable before the truck is loaded and released.

Incorrect production for any 15 minute period will prompt a change in the control of premix feeder to produce the correct fortification level and production will resume.

C. Distribution

Bagged fortified wheat properly marked will be loaded into trucks and dispatched to prescribed distribution/storage points in relation to advanced requirement figures submitted from yearly planning requirements. The LSD requirements are aggregate numbers of needs submitted by the Upazilla, Union etc. planners for local distribution based on the program recipients of the VGD and FFW programs.

On a random time basis, a CSD or LSD will be picked for monitoring. A bag will be selected and sampled with a grain probe for sample collection. The sample will be analyzed for the presence and correct count of PK.

The monitor could carry a UV lamp and perform the analysis on the spot if sample weight could be fixed.

The same random selection and sampling would be carried out at the issue point to program recipients. In this case a sampling container holding 100 gram would be used for taking a sample from a random bag and the PK count determined in the field or in laboratory as planned.

D. System Leakage

It might be desired at some time to know if and/or how much fortified wheat is finding its way into the open market through whatever means. The kernel detection procedure could be used for that purpose.

Wheat samples could be obtained at random from an open market source and tested under UV lamp for the presence of PK that would have originated in fortified wheat.

Annex A. Bagging Line Control Form

The Quality Control person operating on the bagging line needs to record the information gathered from which to control the production of fortified wheat. The following draft form could be developed to serve that need.

Date Time	Scale Setting	Premix Setting	PK Bag	PK Scale	Complete Bag

The QC monitor would make machine settings, draw samples and examine for quality. MOF personnel would bring premix from storage to the fortification floor and keep premix feeder hopper full.

After 3-6 months of operation and perfecting of procedures, a MOF person should start training for sampling and machinery control and then operate the fortification unit for 1-3 months under observation by TECON monitor.

Annex B. Quality Control Equipment

The following equipment will be needed to conduct the quality control activities of the demonstration project.

1. Container for collecting aproximately one pound wheat sample, such as a 500 ml beaker, cup or scoop.
2. Accurate, inexpensive balance for weighing 100 gram of wheat for analysis.
3. Ultraviolet light source. Handheld, table mounted, etc. for use in the quality control center at silo. Additional units(s) may be needed for field use.
4. Grain probe (5 feet) for field monitor to use in sampling bags.
5.* Ink stamp and ink pad with india ink for use in marking bags for fortified wheat.
6.* Stencils and (spray) paint for marking bags for wheat.
7.* Cloth type markers for production coding of fortified wheat bags.

* Equipment needed will depend on the coding technique adopted.

Annex C. Vitamin A Assay Requirements

The vitamin A assay requirements for the demonstration program will come from several sources as indicated below.

1. General production

   Program calls for 30,000 tons of production of about 60T per hour. This represents about 500 samples over the year.

For seven months (May through November) VGD	=	15 per month
For five months (Dec. through April) FFW	=	66 per month
plus VGD	=	15 per month
For five months	=	81 per month

2. Premix shipment

   Premix shipment received each 3 months with at least two samples per shipment = 8

3. Field monitoring

   Samples will be drawn from LSD's and issue points at random, two per month = 24

4. Yearly total

   Potential number per year in range of 550 samples

   Uneven distribution Lowlevel for seven months

   High level for five months